

Part 3: Mobile Retroreflectivity Programs

(20–25 minutes)



This portion of the presentation covers the mobile retroreflectivity programs that are listed and required in Item 666 and the Special Specification “Mobile Retroreflectivity Data Collection for Pavement Markings.” TTI manages both of these programs and reports to TxDOT Materials and Tests Division (MTD).

Mobile Retroreflectivity Programs Outline

- Mobile Retroreflectivity Certification
 - Overview
 - Requirements
 - Certified Providers/Equipment
- Mobile Retroreflectivity Verification
 - Overview
 - Responsibilities
 - TTI
 - TxDOT
 - Provider
 - Results
 - Maintaining Certification

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The two programs are the mobile retroreflectivity certification program and the mobile retroreflectivity verification program. The certification process is necessary to make sure the operators and equipment have the ability to collect accurate data and submit those data in compliance with TxDOT specifications. The certification program does not guarantee the providers will collect accurate data in the field. The certification program is for new providers, new operators, new equipment, and providers who have lost certification.

The verification program is being used to evaluate field performance of the providers on TxDOT jobs. Observations and inspection by TxDOT are also necessary to make sure providers are collecting accurate data.

TTI conducts both the certification and verification programs.

Certification Program Background

- Certification program started in Spring 2007
- Program was developed after TxDOT questioned the validity of mobile retroreflectivity data submitted as part of a contract
- The data were highly variable and didn't always make sense
- TxDOT questioned the ability of the provider to operate the equipment and wanted providers to be tested to make sure they have the ability to collect accurate data

TxDOT and TTI worked together to develop the program, which TTI manages.

Certification Program Overview

- Prior to conducting work for TxDOT, providers must come to TTI and pass the certification test
- Certification testing is required for all new operators and equipment
- There is a fee associated with the certification test
- In the past, certification was maintained through annual recertification
- Certification is now maintained through the field verification program
- Loss of certification due to poor retroreflectivity verification results requires full recertification testing

Certification Program Overview

- Closed-course and open-road testing
- All line types and colors measured
- Certification program guide details information about the program
- Certification guide and other information can be found on the certification website:

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/mobile-retro-certification/certified-providers/>

Certification Program Overview



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Closed-course test area at the Texas A&M University System RELLIS Campus.

Markings cover a range of retroreflectivity levels and marking material types.

Paint, thermoplastic, structured thermoplastic, epoxy, and tape are included on certification course.

Open-road tests include thermoplastic and paint pavement markings.

Certification Testing Requirements

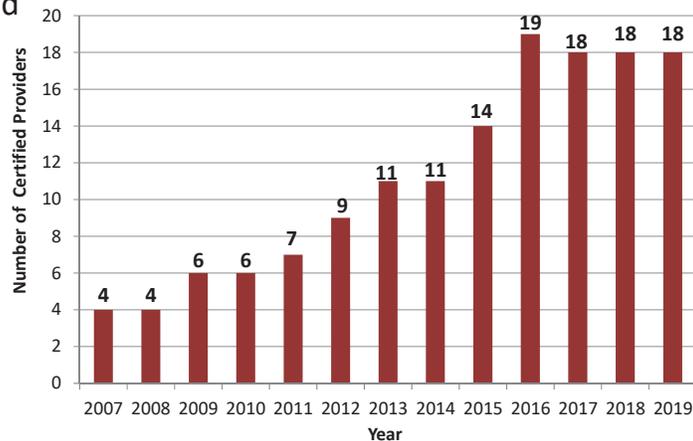
- Mobile retroreflectivity data must be within $\pm 15\%$ of the portable retroreflectivity value collected on the same pavement marking segments
- Data are evaluated for each individual run and for the test as a whole
- Contactors must submit examples of data, map, and video files that meet specification requirements

Comparison portable measurements are taken frequently on the test marking, at 20–40 foot spacing. These measurements are typically within 1 day of the certification test.

The provider mobile retroreflectivity data are compared to the TTI portable retroreflectivity data. TTI also evaluates the markings with its mobile retroreflectometer and incorporates those data into the comparison as well.

Number of Certified Providers

- Five different mobile retroreflectometer types have been certified



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There are currently four different mobile retroreflectometer types certified. One of the previously certified retroreflectometer types is no longer certified.

The total number of providers certified fluctuates some if providers lose certification or if out-of-state providers do not maintain certification.

The jump in providers in 2015 and 2016 is likely due to the TxDOT mandate on initial retroreflectivity requirements for most new markings that was released in early 2015.

List of Certified Providers/Operators and Equipment

- List can be accessed on the certification program website
- List is regularly updated as new operators or equipment certify, or if a provider loses certification

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/mobile-retro-certification/certified-providers/>

The screenshot shows the TTI Visibility Research website. The header includes the Texas A&M Transportation Institute logo and the text "TTI Visibility Research". A navigation menu contains links for "About", "Research Areas", "Projects", "Publications", "Facilities", "People", and "News". The main content area features a breadcrumb trail: "Home > Programs and Guidance > Mobile Retroreflectometer Certification Program > Certified Providers". Below the breadcrumb is a section titled "Certified Providers" with a table. The table has four columns: "Provider", "Operator", "Certified Period*", and "Equipment (serial number)".

Provider	Operator	Certified Period*	Equipment (serial number)
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Mobile Retroreflectivity Verification Program

- Federal regulations require DOTs to verify provider test results for performance-based product acceptance
- Guideline is to perform verification on a minimum of 10% of projects
- TTI is working with TxDOT to meet these requirements
 - Verification or spot monitoring can also be conducted by districts contracting the work to ensure accurate data are consistently collected

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/retroreflectivity-verification-program/>

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Most longitudinal markings have retroreflectivity requirements that need to be met for project acceptance.

Verification testing was added to Special Specification 6291.

TTI is conducting a formal verification testing program. TxDOT districts still need to monitor the providers at some level to make sure they are following the specifications, installing quality markings, and providing accurate data.

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/retroreflectivity-verification-program/>

TTI Responsibilities

- Manage verification program
- Coordinate field verification evaluations
- Analyze data from field evaluations
- Report to provider and TxDOT on field verification evaluation results
 - Each job included in verification program
 - Monthly reports to MTD
 - Annual report to MTD
- Recommend changes to the program as necessary

These are the major responsibilities for TTI. Each will be discussed in more detail on the following slides.

Verification Program Management

TTI is:

- Using a SiteManager materials report to monitor and assist in project selection
- Initially selecting 20% of projects, with a goal of evaluating 15% to ensure the 10% requirement is met
- Coordinating field evaluation and reporting results
- Notifying providers of program changes

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TxDOT has provided TTI with access to SiteManager to access project information for projects that include Item 666. This allows TTI to identify projects and monitor when and how many projects have been let.

The goal is to select more projects than needed because ultimately all of them will not be evaluated. Things like weather, bad data, construction delays, issues with the provider, unavailability, etc. may prevent specific projects from being evaluated in a timely manner as compared to when the provider evaluates the markings.

Part of the management of the program is coordinating the field evaluations and reporting the results; those areas will be described later in this section.

TTI, in cooperation with TxDOT, will notify the providers of changes to the program or changes to specifications.

Coordinate Verification Evaluations

- Providers notify TTI of measurements
- TTI verification data are collected within 7 days of provider data
- TTI schedules readings to get a representative distribution around the state and among providers
- Providers will not know which projects TTI has selected for verification testing

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Providers are required to notify TTI at least 24 hours in advance of conducting mobile retro readings. TTI hopes providers will send a weekly plan on Monday of what they anticipate reading during the week. This will allow TTI to better plan data collection and will result in TTI collecting data closer to when the providers collect their data.

TTI data need to be collected in the nearest time frame possible to the provider to minimize potential differences in the data due to outside factors such as weather, traffic, dirt, etc. TTI will try to collect data within 3 days of the provider.

Providers will be evaluated multiple times per year. If providers have had issues with readings, they will be evaluated more frequently to make sure their readings are meeting the accuracy requirements. For example, TTI evaluates a provider who has had accurate data in the past but whose most recent evaluation is well outside the accuracy requirements. TTI will look to evaluate the provider again in a short time frame to see if it has implemented corrective action (described later) or if it possibly has equipment issues that will require it to have its equipment serviced. Loss of certification based on verification results will be described later.

In previous years, scheduling required TTI to contact the providers to determine when and where they were taking measurements. The providers could assume if TTI was contacting them that TTI was going to evaluate those jobs. With the changes to Special Specification 6291, the providers now need to notify TTI of all measurements they will be taking, so they will not know which jobs have been selected for verification testing.

Analyze Data

- Provider mobile data are compared to TTI mobile data (supplemented with portable readings for accuracy verification)
- Data must differ by 20% or less to meet verification accuracy requirements
 - Data between 20% and 35% = 1 strike
 - Data exceeding 35% difference = 2 strikes
- TTI will also check to see if the data meet the minimum retroreflectivity requirements

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TTI regularly maintains its mobile and portable retroreflectometers and constantly tests them to ensure accurate data are collected. Mobile measurements are supplemented with portable measurements to verify accuracy.

Provider collected data must be within 20% of the TTI data to meet the verification accuracy requirements. If the data differ between 20 and 35%, the provider will get a strike, and if the data differ by more than 35%, the provider gets two strikes. Three consecutive strikes will result in the provider losing certification and needing to go through the certification process again in order to be able to collect data on TxDOT projects. The provider will lose a strike (if it has one) if the provider's data meet the verification accuracy requirements.

TTI will check if the data meet the Item 666 minimum initial retroreflectivity requirements, 250 for white and 175 for yellow.

Reporting Results

- Individual jobs are reported to the provider and district
 - Did provider meet verification requirements?
 - Did markings meet retroreflectivity requirements?
- TTI submits monthly reports to MTD documenting verification evaluations
- TTI submits annual report to MTD documenting all work completed and program status

In the past, results have only been going to the providers and MTD. The results were not sent to the district unless requested. Results will be sent to the districts in the future.

TTI will continue to update MTD on a monthly and annual basis. As needed, meetings will also be held to discuss the status of the program and any changes that would be beneficial.

Annual Program Review

- Annual report will include a section reviewing the program
 - How are the providers doing?
 - Accuracy of readings
 - Quality of markings
 - Are the accuracy requirements set to an appropriate level?
 - Are changes needed for notifications, reporting, or corrective action requirements?
- Recommend changes to the program will be made as necessary

With each annual report, TTI will describe the work conducted, the results, and if any changes should occur to improve the program.

Feedback collected throughout the year from providers, districts, and MTD will be considered when making recommendations on changes to the program.

TxDOT Responsibilities

- Support verification program
- Conduct referee testing (MTD)
- Contact TTI for specific jobs to evaluate
- Ensure providers are certified
- Make sure providers are following the specifications
- Hold providers accountable

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These are district or area office level responsibilities, except for the first two bullets. The last four bullets are TxDOT responsibilities that apply to all pavement marking jobs, not just those included in the verification program. The districts need to monitor all pavement marking projects, make sure contractors submit the appropriate data, and review the data to make sure they meet requirements. TTI is only evaluating contractor data for a portion of the projects across the state.

TxDOT can contact TTI to evaluate specific projects if desired.

TxDOT needs to go to the certification website to make sure the providers that are performing work are certified. TxDOT can contact TTI directly if they have any questions about certification status.

TxDOT should make it clear in the contract if it desires any specific changes to the specifications. Things such as data formatting or what data to collect and submit may be desirable to change. Providers need to turn in sample data to prove they can supply the specified data. Providers must also notify TxDOT about upcoming measurements.

Providers need to be held accountable. They need to collect and turn in data on time. If they delay in collecting the data, the minimum requirements should not be relaxed. If markings are below minimum retroreflectivity requirements, they need to be restriped. If providers are not providing the data that they should be, and the data are wanted, then they need to provide those data at no additional cost.

Referee Testing

- The Engineer can request referee testing if the data do not validate and results are conflicting for meeting minimum retroreflectivity requirements
- MTD will perform the referee testing using portable retroreflectometers
- Referee testing will be conducted according to Item 666 portable retroreflectometer measurements

Referee testing needs to be requested as soon as possible. The influence of other factors (traffic, weather, etc.) will have a greater impact the longer the time is between the first set of collected data and the referee testing. If the time frame is too long, the referee data may differ solely because of these other factors and may not reflect the quality of the pavement markings during the 3–10 day window when initial retroreflectivity is supposed to be evaluated. That being said, if a marking loses a large portion of its retroreflectivity in a short time frame, then the marking was likely not very good to begin with.

Provider Responsibilities

- Meet contract and specification requirements
- Provide sample data
- Receive authorization for retroreflectivity measurements from engineer
- Notify TxDOT and TTI at least 24 hours prior to mobile measurements
- Submit data to TxDOT and TTI
- Maintain equipment and certification status
 - Certification
 - Accurate field verification evaluations
 - Perform corrective actions when necessary

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Providers need to meet the requirements of the TxDOT specifications.

These requirements include:

- Providing sample data for TxDOT to review.
- Not starting retroreflectivity readings until given authorization from the TxDOT Engineer.
- Providing notification to TxDOT and TTI at least 24 hours prior to collecting retroreflectivity data on any individual job.
- Submitting the collected, summarized, and properly formatted data to TxDOT and TTI.

Providers must maintain their equipment so that it can collect accurate data.

Providers must also maintain certification of their equipment and operators. Initial certification can be obtained through the TTI certification program. Maintaining certification occurs through collecting accurate field data as part of the verification program.

If necessary, providers must perform corrective actions in the event that field verification data do not meet accuracy requirements. These actions will be provided by TTI when the verification results are provided.

Provider Corrective Actions

- Corrective actions need to take place or else certification status can be lost after multiple failed verification tests
- Recommended corrective actions will be provided to the provider with the results
- Possible corrective actions
 - Have equipment serviced
 - Improve calibration procedure and frequency
 - Adjust software settings
 - Monitor data collection conditions

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These are examples of corrective actions. Specific actions, such as the specific software setting to adjust or monitor, will be provided on a case-by-case basis. Corrective actions need to take place to improve accuracy of collected retroreflectivity data to reduce the chances of failing future verification evaluations.

Some data differences may be caused by the environment and will be noted in the results. Seal coat roadways are typically more difficult to stripe with a new marking than other road surfaces due to the profile of the road surface. It is especially difficult to stripe a yellow centerline because the opposite direction of application often gets fewer beads due to the forward motion of the striping and the profile of the aggregate. Seal coat roadways may bleed asphalt that can get tracked on the markings. This is typically not the fault of the striping company and needs to be accounted for when conducting verification readings, reporting on the results, and holding the providers accountable.

Verification Results

- TTI will check two things:
 1. Do the provider data fall within $\pm 20\%$ of the TTI data?
 2. Do the provider and/or TTI data meet the retroreflectivity requirements?
- Item 1 is for the verification program; TTI will take action on failing data.
- Item 2 is additional comparison provided to TxDOT to make sure the markings are meeting specifications; TxDOT will need to take action on failing or questionable data.

In the TTI responsibilities section, the data analysis and reporting of the results were discussed.

This section provides additional details as to what is being compared and how the results are to be used.

Notification of Results

- TTI will provide the results to the TxDOT engineer in charge of the project as well as the provider
- Possible results:
 - Data are verified and are above requirements (*good*)
 - Data are verified but are below requirements (*restripe*)
 - Data are verified but are above/below requirements (*referee test?*)
 - Data are not verified but are above requirements (*corrective actions*)
 - Data are not verified and are below requirements (*restripe, corrective actions*)
 - Data are not verified and are above/below requirements (*referee test? corrective actions*)

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TTI will notify both the provider and the TxDOT engineer in charge of the project. It is impossible for TTI to know the correct contact for each project since districts handle striping differently. Even within districts, maintenance or construction striping is often handled differently. TTI will send the results to the person noted as the project contact. It is expected that that person, if they are not the correct person, will send the information on to the correct person. Over time, as contact is made with each district, a list of appropriate contact persons will be developed if there are specific people at the districts who deal with striping or the retroreflectivity data.

There are six basic scenarios of the results. Only one of them is good for both the verification testing and meeting the minimum retroreflectivity requirements. The other five are a combination of passed and failed verification with passed, failed, or inconclusive on meeting the minimum retroreflectivity requirements. When the data are inconclusive on meeting the minimum retroreflectivity requirements, referee testing may be necessary.

Sample Results Notification



Pavement Marking Retroreflectivity Verification Testing Report

Report #: _____

District:		Test Date:	
Project #:		Test Performed By:	
County:		Contractor Operator:	
Receiving Engineer:		Contractor Test Date:	
Contractor:			
Road:		Verification Results:	
Road Surface:		Required Action(s):	
Marking Material:			
Evaluation Area Location:			
Markings Evaluated:			

Summary Data:

Marking	# Readings	Contractor		TTI			% Diff.
		Average	St.Dev	# Readings	Average	St.Dev	
1							
2							
3							
4							
5							

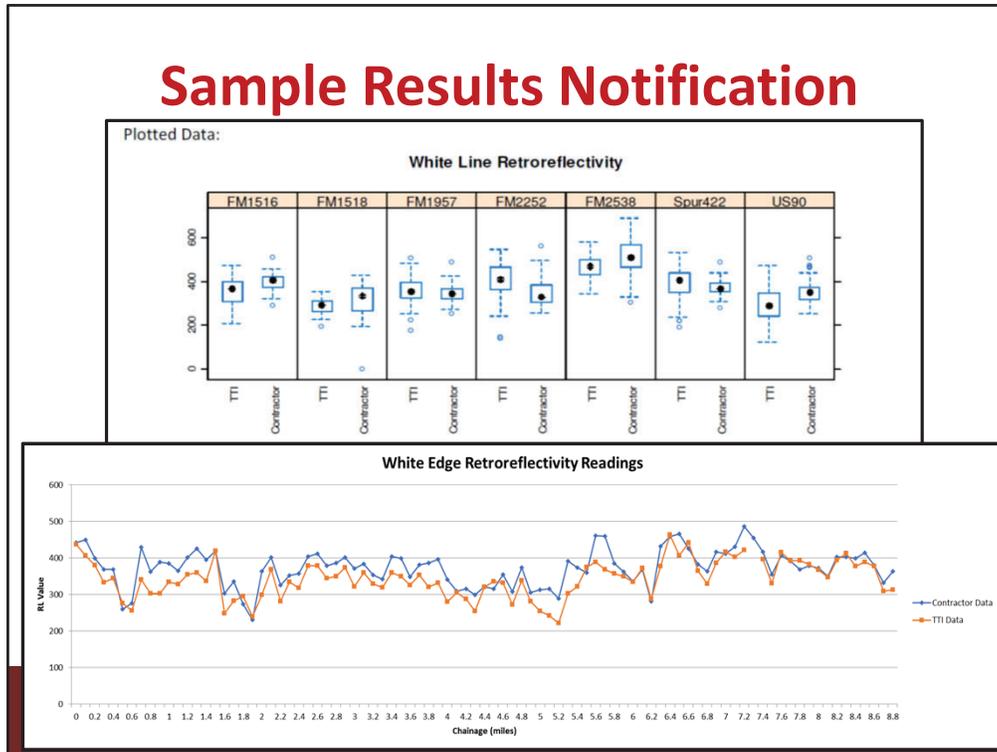
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This is an image of a sample results notification form. The design and content on the form may change as feedback is received from districts.

General information on the project evaluated will be provided with the results.

Summary information on the results will be provided on a line-by-line basis as well as for the whole project.

Sample Results Notification



In addition to general information on the project evaluated, the data collected may also be displayed. This slide has two different methods of displaying the data.

The top chart is a way to show the distribution of the data collected over the entire length of the pavement marking in a simple box and whisker plot. It shows the average and the distribution of the data. These plots can be used to show the differences between the TTI and provider data. This method of displaying the data is more useful for the verification program because it is more concise it does not show how the retroreflectivity changes along the length of the line, just the aggregated data over the entire length.

The bottom chart is more useful for determining if the data pass minimum retroreflectivity requirements or not. The data indicated in the graph are from a white edge line that passed verification. There was an 8.5% difference between the TTI and provider data. On average, the provider data were about 30 mcd/m²/lux higher than the TTI data over the length of the project. There were only a couple of short areas where the retro value fell below the minimum requirements. The specific data outputs would need to be evaluated to determine if restripe was needed. This will be discussed in Part 5 of the presentation, which focuses on the data requirements and how to analyze the data.

Maintaining Certification

- Continued accurate field verifications
- Data must differ by 20% or less to meet verification accuracy requirements
 - Data between 20% and 35% = 1 strike
 - Data exceeding 35% difference = 2 strikes
- Three strikes result in the loss of provider certification, and require full recertification at TTI
- Passed verification results in loss of a strike

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Provider-collected data must be within 20% of the TTI data to meet the verification accuracy requirements. If the data differ between 20 and 35%, the provider will get a strike, and if the data differ by more than 35%, the provider gets two strikes. Three consecutive strikes result in the provider losing certification and needing to go through the certification process again in order to be able to collect data on TxDOT projects. The provider will lose a strike (if has one) if the provider's data meet the verification accuracy requirements.

Summary

- Mobile Retroreflectivity Programs
 - Mobile Retroreflectivity Certification
 - Mobile Retroreflectivity Verification

The certification and verification programs serve two separate but related purposes. The providers need to meet the requirements of both programs, and TxDOT needs to hold them accountable. TTI has to rely on input from the providers and TxDOT. If the providers are not following the program rules, then TxDOT needs to notify TTI and hold the provider accountable. If providers are not held accountable, it will hurt the quality of markings being applied and creates an inequitable contracting environment in which different providers may be held to different standards by different districts.

This concludes the discussion of the certification and verification programs.